NOTES ON THE ROOTING OF SOME CONIFERS FROM CUTTINGS*

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With one text-figure and one plate

SOME two years ago, the authors reported (1939) experiments on the rooting of "difficult" plants, including hemlock, Norway spruce, and white pine. In the course of the subsequent work, which was mainly directed to more general problems, observations have been made on the rooting of a number of other coniferous trees. While these data do not disclose any new principles, they provide information as to the relative ease of rooting of several important species and will therefore be reported briefly.

ABIES. Experiments were made from time to time over a period of 13 months, from March to April of the succeeding year, on two species of *Abies,* to determine (a) the optimum time for rooting, (b) the optimum auxin treatment. Cuttings were taken from trees in the Arnold Arboretum, of various ages between 12 and 50 years, and the results are averaged in table 1. Since treatment with sucrose had previously been found to be beneficial, the bases of the cuttings were in most cases immersed in 2% sucrose for 48 hours following auxin treatment. Where comparisons were made, sucrose treatment had a definite but small beneficial effect. In order to simplify the presentation, all the data in tables 1 and 2 refer to sucrose treatment unless otherwise indicated. Sucrose did not induce rooting in the summer months, and, in general, its effect was mainly in tending to improve the maintenance of the cuttings where rooting was taking place. Vitamin B_1 was completely without effect on the rooting of either of these species.

The superiority of the winter months is very evident, especially January for *Abies koreana,* and March for *Abies concolor.*

The optimum auxin treatment is less clear, although the cuttings are clearly capable of responding to auxin. However, it appears that at the time of year when rooting is slight, 100 mg. per litre is about optimal, while when rooting is vigorous, 200 mg. per litre is preferable.

Comparison of trees of different ages appears to show, at any rate without auxin treatment, that the decreasing responsiveness of older trees persists over a wide age range. The data for winter cuttings of *A. concolor* (sugar-treated) are summarized in table 2. While, in white pine, the ability to root well fades out at 4 to 5 years, in *Abies,* it apparently persists up to 18 years of age.

*These experiments were carried out under the auspices of the Maria Moors Cabot Foundation for Botanical Research.

TABLE 1.

PERCENTAGE ROOTING OF TWO **Abies** SPECIES.
All cuttings treated with auxin (or water) for 24 hours,
then 2% sucrose for 48 hours, except where marked †

Month in which cuttings were taken	Abies koreana			Abies concolor		
	Auxin concentrations in mg./l.					
	0	100	200	0	100	200
March 1938	0†	16†	5†	—	—	—
July 1938	0	0	0	0	0	0
August 1938	0†	7†	0†	0†	0†	0†
December 1938	—	—	—	2	18	7
January 1939	25†	33†	70†	—	—	—
March 1939 (mean of 2 collections)	0	18	17	19	68	43
April 1939	0	10	0	0	0	0

TABLE 2.

EFFECT OF AGE ON ROOTING OF **Abies concolor**
Mean value of cuttings taken in December and March. All cuttings
treated with 2% sucrose for 48 hours following auxin treatment.

Age in years	Percentage of Rooting	
	Water controls	auxin 100 mg./l.
12	40	72
18	10	35
25	0	15
47	0	80

Results obtained with *Abies pectinata* (silver fir) are remarkable for the slowness of the response to auxin treatment. Cuttings obtained from an old tree at Sandwich, Mass.[2] in January, and kept in sand, showed no change for 5 months. Rooting then began, and after 7 months about 25% of those treated with auxin had rooted, while controls showed no roots. After 12 months those which had been treated with indole-acetic acid 100 mg. per liter gave 31% rooting; with 200 mg. per liter 45% rooted in the same time. The latter concentration gave slightly more extensive root systems, as shown by the representative cuttings in figure 1. Water controls showed only 6% rooting in the 12 months. Thus the effect of

[2]Obtained through the courtesy of Mr. Frank Sargent of The Massachusetts Department of Conservation, Bureau of Forestry.

a single 24-hour treatment only became observable many months afterwards, although it was ultimately of large magnitude. Cuttings whose base consisted of two-year-old wood, i.e. those cut at the base of the 1937 growth, rooted even better (4% in water, 27% in 100 mg. per liter and 80% in 200 mg. per liter after 12 months). Cuttings whose base consisted of three-year-old wood, however, rooted less than half as well as the standard one-year material. This species must thus be regarded, in the absence of more extended trials, as a relatively easily rooted plant.

As a whole it seems that the *Abies* species are capable of rooting in good percentage from old trees.

TSUGA. The good results previously reported on *Tsuga canadensis* L. taken in the fall from individual trees in the Arnold Arboretum, have since been found to be not obtainable with certain other trees. The response may, therefore, vary from clone to clone.[3]

A study of the effect of age of tree in *Tsuga diversifolia* gave the results summarized in table 3. Young trees[4] gave excellent rooting on auxin treatment; old trees gave good values when taken in December, but not at other

TABLE 3.

Tsuga diversifolia. RESULTS AFTER 9–12 WEEKS IN SAND-PEAT MIXTURE.

Age of trees in years	Month in which cuttings were taken	Auxin concentration in mg./l.				
		0	25	100	200	400
3	December 1938	8	20	73	55	—
6	December 1938	4	25	50	63	—
42–60	December 1938	14	—	30	43	29
	March 1939	0	—	14	0	—
	August 1938	0	—	0	0	—

times. It will be noted that no effect of age is shown in the water controls with this species. This contrasts with the results previously found for *Pinus Strobus* and *Picea Abies*. On the whole *Tsuga diversifolia* cannot be regarded as among the most "difficult" of trees. A treatment with vitamin B_1 (0.5 mg. per liter), following auxin, had no effect on the number of cuttings rooted or on the size of the root systems and in two instances even slightly decreased the rooting. Representative cuttings are shown in figure 2. Actively growing terminal or subterminal branchlets were used.

[3]Zimmerman and Hitchcock (Contrib. Boyce Thompson Inst. **10**: 474. 1939), in misquoting these results, lay emphasis on their finding for *Tsuga canadensis* that the age effect is "certainly not the principal limiting factor as claimed by Thimann and Delisle." As a matter of fact, the data we reported were with cuttings from old trees, *Tsuga canadensis* being one of the few conifers in which we found no effect of the age of the plant.

[4]Obtained through the courtesy of Verkade's Nurseries, Wayne, N. J.

PICEA. As with *Abies*, the rooting of blue spruce, *Picea pungens*, was followed at intervals throughout the year. A number of trees of medium age, 10–20 years, were used. Table 4 shows that no controls rooted at any

TABLE 4.

Picea pungens, AGED 10–20 YEARS. RESULTS AFTER 12 WEEKS IN SAND.

Month in which cuttings were taken	Auxin concentration in mg./l.		
	0	100	200
June 1938	0	0	0
August 1938 (two separate collections)	0	0	0
November 1938	0	43	27
February 1939 (two separate collections)	0	0	0
April 1939	0	80	57
June, July 1939	0	0	0

time, while a good response to auxin was obtained, limited to the winter and spring months. The optimum concentration is apparently 100 mg. per liter (when treatment is for 24 hours), the optimum time being in the spring. However, the absence of rooting on February cuttings suggests that data of a second season would be very desirable.

Picea Omorika, Serbian spruce, taken throughout the winter months, gave no rooting. Cuttings from four-year-old trees,[5] however, gave moderate rooting. This plant presents one of the very few cases where we have obtained a real effect of treatment with vitamin B_1. As table 5 shows,

TABLE 5.

Picea Omorika. CUTTINGS TAKEN FROM TREES 4 YEARS OLD. RESULTS AFTER 12 WEEKS IN SAND-PEAT MIXTURE.

Treatment	Auxin concentration mg./l.			
	0	25	100	200
Auxin (or water) 24 hours, then water 24 hours	4	18	26	36
Auxin (or water) 24 hours, then vitamin B_1, (0.5 mg./l.) 24 hours	17	30	49	66

cuttings treated with vitamin B_1 gave increased rooting at all auxin concentrations. The roots were also more numerous.

Some of the data of tables 1, 3 and 4 are summarized in the text-figure, which shows simply the highest percentage rooting obtained in each month,

[5]See above, (4)

irrespective of the auxin concentration used. In all cases, however, this was either 100 or 200 mg. per liter. The experiments are not numerous enough to define the optimum rooting times exactly, but the general trends are clear enough.

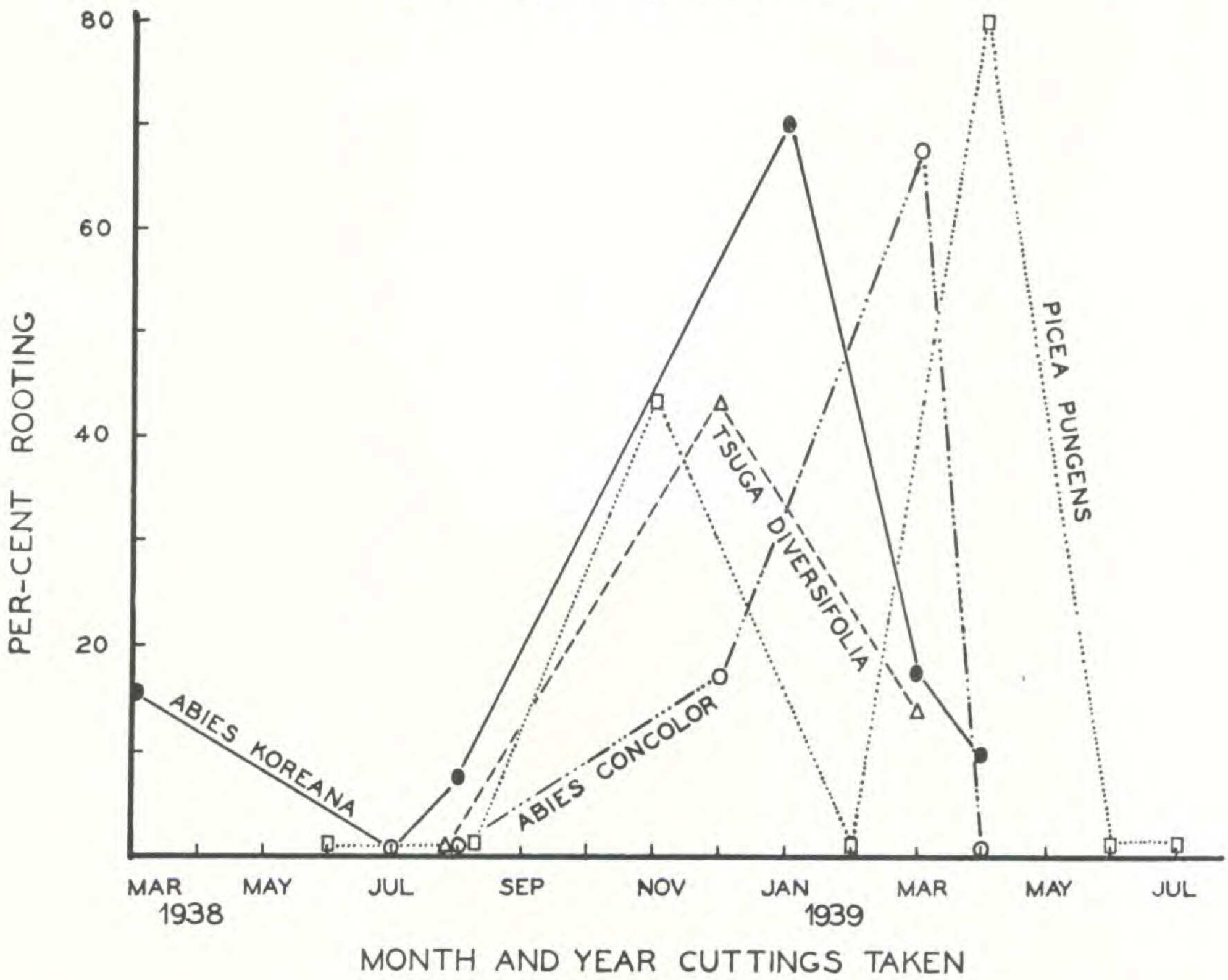

FIGURE 1

OTHER SPECIES. Table 6 gives data on three other trees considered as particularly interesting. It will be seen that *Podocarpus* roots readily, and *Sequoia* moderately so. Rooting of the latter from cuttings has, so far as the authors are aware, not been reported. Summer cuttings of *Sciadopitys* showed the unusual effect of a reduction in rooting by auxin treatment (cf. the results of Deuber and Farrar (1939, 1940) on *Picea Abies*). December cuttings behaved more normally. Vitamin B_1 was again without appreciable effect. Rooting of *Sciadopitys*, 4, 5, and 9 years old, has recently been reported by DeFrance (1938 a, b). Taking the data of tables 3–6 together, it is apparent that either 100 or 200 mg. per liter represents optimal auxin treatment for a number of trees.

An interesting observation was made on *Pinus Strobus* (white pine). Among a large number of cuttings, a few isolated brachyblasts or short

TABLE 6.

ROOTING OF OTHER CONIFERS.

Plant	Month	Age in years	Auxin concentration in mg./l.	Number of weeks required for rooting
			0 50 100 200	
Podocarpus neriifolia	March 1939	36	25 — 100 100	9-14
Sequoia sempervirens	March 1939	10	0 — 34 20	11
Sciadopitys verticillata	August 1938*	40	43 33 30 0	32
verticillata	December 1938	40	0 — 22 0	28
verticillata	December 1938 (treated with vitamin B_1)	40	0 — 29 0	28

* Of the cuttings alive and unrooted 3 months later, one half of each group were given a biotin preparation; there was no effect.

shoots (needle bundles, or fascicles) became accidentally embedded in the peat-sand medium. Several of these rooted. The rooting of these individual brachyblasts was then studied further, and it was found that the brachyblasts from old trees show slight but definite rooting on auxin treatment, while those from young trees root very vigorously. Table 7 shows that up to 74% rooting (71 out of 97) eventually was obtained with 3-year-old trees. This is probably higher percentage rooting than would be given

TABLE 7.

PERCENTAGE ROOTING OF BRACHYBLASTS OF **Pinus Strobus,** TAKEN IN NOVEMBER, TREATED 24 HOURS, THEN KEPT IN PEAT-SAND MIXTURE.

Age of tree in years	Auxin concentration in mg. per liter			Time of first rooting	Time of complete rooting
	0	50	100		
3	7.5	31	74	3 months	9 months
80	0.0	3	0.5	3½ months	3½ months

by ordinary cuttings. It is also remarkable that the effect of age of the tree is so clearly shown in this material. As mentioned in a preliminary report (Delisle, 1940) the rooted brachyblasts, transferred to soil, do not usually survive more than a few months, unless an active bud is already present. This fact would seriously limit the immediate application of this material in practical propagation. However, the whole phenomenon is now being

Figure 1

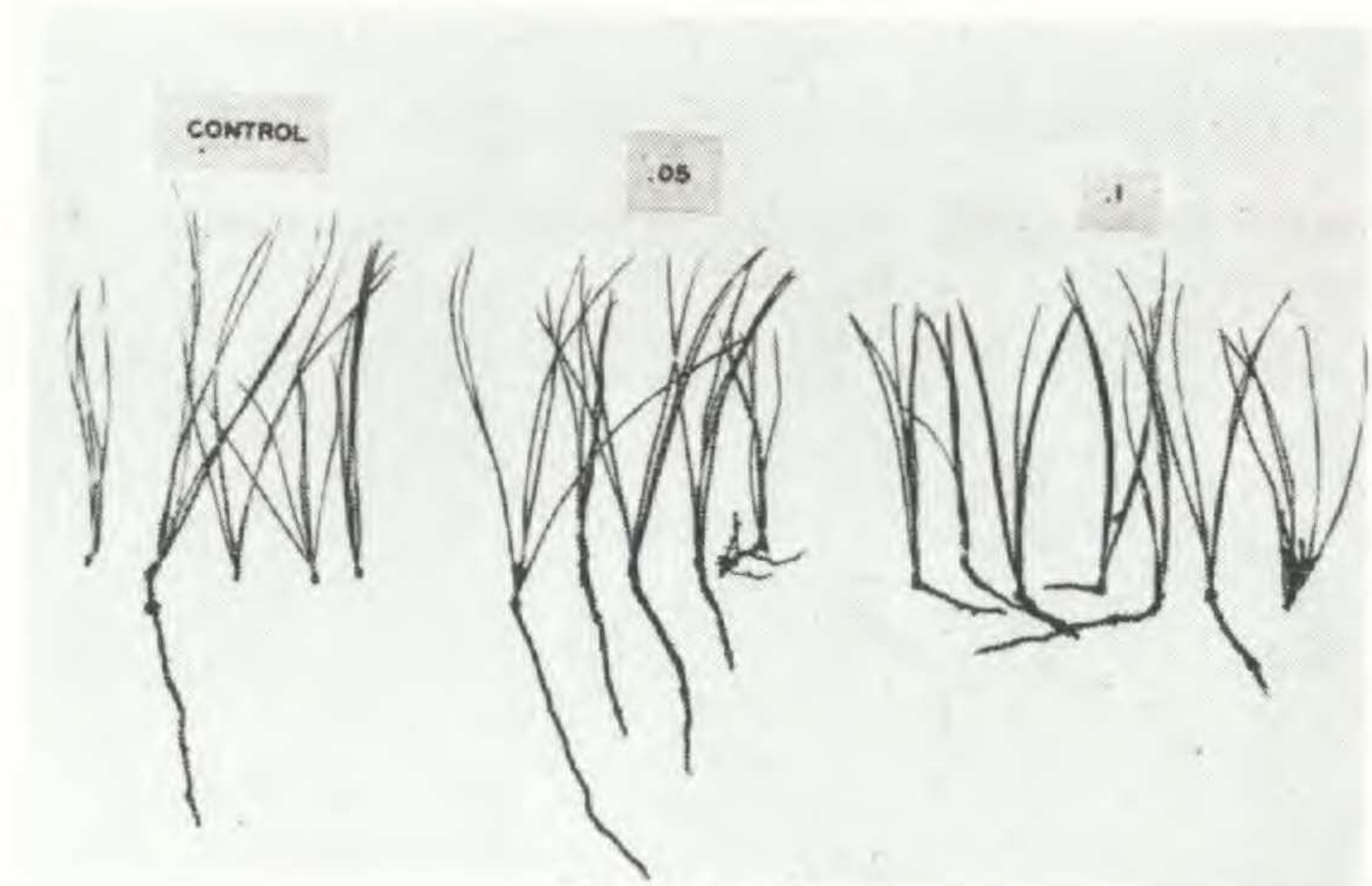

Figure 3

Figure 2

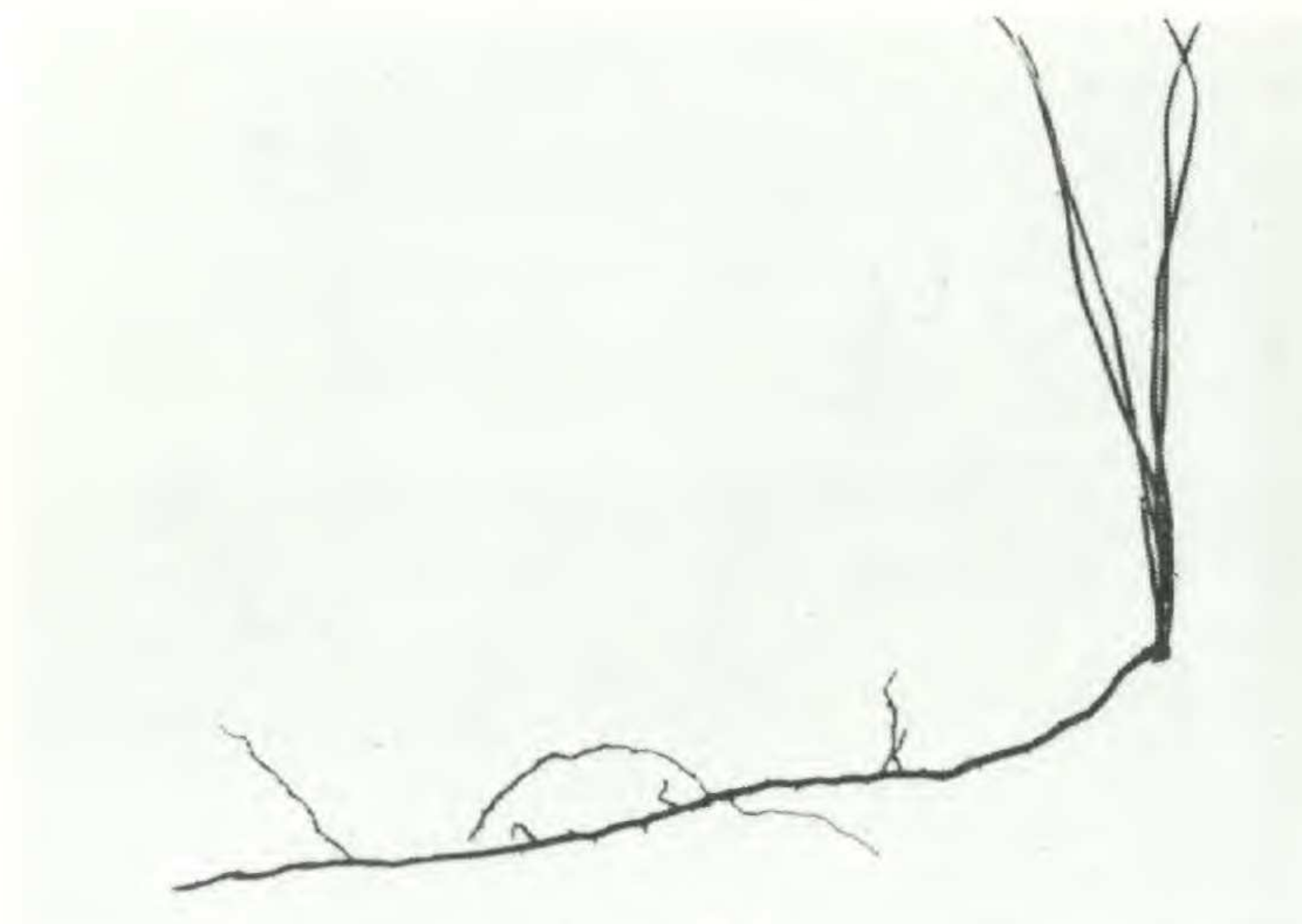

Figure 4

Rooting of some Conifers from Cuttings